# General

## Guideline Title

ACR Appropriateness Criteria® osteonecrosis of the hip.

## Bibliographic Source(s)

Murphey MD, Roberts CC, Bencardino JT, Appel M, Arnold E, Chang EY, Dempsey ME, Fox MG, Fries IB, Greenspan BS, Hochman MG, Jacobson JA, Mintz DN, Newman JS, Rosenberg ZS, Rubin DA, Small KM, Weissman BN, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness CriteriaÂ® osteonecrosis of the hip. Reston (VA): American College of Radiology (ACR); 2015. 12 p. [67 references]

## Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Seeger LL, Daffner RH, Weissman BN, Arnold E, Bancroft L, Bennett DL, Blebea JS, Fries IB, Jacobson JA, Morrison WB, Payne WK III, Resnik CS, Roberts CC, Schweitzer ME, Taljanovic M, Wise JN, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness Criteria® avascular necrosis (osteonecrosis) of the hip. [online publication]. Reston (VA): American College of Radiology (ACR); 2009. 5 p. [22 references]

This guideline meets NGC's 2013 (revised) inclusion criteria.

# Recommendations

## Major Recommendations

ACR Appropriateness Criteria®

Clinical Condition: Osteonecrosis of the Hip

Variant 1: Adult or child. Clinically suspected osteonecrosis. First study.

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| X-ray pelvis and hips | 9 | This procedure includes the frog-leg view. The RRL for the adult procedure is . | |
| MRI hips without contrast | 7,8,9 Usually appropriate | The RRL for the adult procedure is | *Relative |

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| | | | |
| CT hips with contrast | 1 | The RRL for the adult procedure is . | |
| CT hips without and with contrast | 1 | The RRL for the adult procedure is . | |
| Tc-99m bone scan with SPECT hips | 1 | The RRL for the adult procedure is . | |
| MRI hips without contrast | 1 | | O |
| MRI hips without and with contrast | 1 | | O |
| Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Adult. Clinically suspected osteonecrosis. Normal radiographs or radiographs that show femoral head lucencies suspicious for osteonecrosis.

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI hips without contrast | 9 | | O |
| CT hips without contrast | 5 | | |
| MRI hips without and with contrast | 5 | | O |
| Tc-99m bone scan with SPECT hips | 4 | | |
| CT hips with contrast | 1 | | |
| CT hips without and with contrast | 1 | | |
| Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Child. Clinically suspected osteonecrosis. Normal radiographs or radiographs suspicious for osteonecrosis.

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI hips without contrast | 8 | | O |
| MRI hips without and with contrast | 8 | | O |
| CT hips without contrast | 1 | | |
| CT hips with contrast | 1 | | |
| CT hips without and with contrast | 1 | | |
| Tc-99m bone scan with SPECT hips | 1 | | |
| Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 4: Adult. Osteonecrosis with femoral head collapse by radiographs in the painful hip(s). Surgery contemplated.

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI hips without contrast | 8 | This procedure is recommended for affected hip preoperative planning and status of contralateral hip. | O |
| CT hips without contrast | 7 | This procedure is recommended for affected hip preoperative planning. | |
| Tc-99m bone scan with SPECT hips | 3 | | |
| MRI hips without and with contrast | 1 | | O |
| CT hips with contrast | 1 | | |
| CT hips without and with contrast | 1 | | |
| Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| | | | |
| Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 5: Child. Osteonecrosis with femoral head collapse by radiographs in the painful hip(s). Surgery contemplated.

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI hips without contrast | 8 | | O |
| MRI hips without and with contrast | 7 | | O |
| CT hips without contrast | 5 | This procedure may be appropriate but there was disagreement among panel members on the appropriateness rating as defined by the panel's median rating. | |
| Tc-99m bone scan with SPECT hips | 3 | | |
| CT hips with contrast | 1 | | |
| CT hips without and with contrast | 1 | | |
| Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 6: Adult or child. Osteonecrosis clinically suspected. Radiographs normal or abnormal but MRI contraindicated. Further evaluation is needed.

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| CT hips without contrast | 9 | This procedure is more specific than bone scintigraphy and allows anatomic assessment, particularly with abnormal radiographs. The RRL for the adult procedure is . | |
| Tc-99m bone scan with SPECT hips | 8 | This procedure is more sensitive than CT (SPECT/CT should be performed if possible), particularly with normal radiographs. The RRL for the adult procedure is . | |
| Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| CT hips with contrast | 1 | The RRL for the adult procedure is . | |
| CT hips without and with contrast | 1 | The RRL for the adult procedure is | |
| Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Summary of Literature Review

Introduction/Background

Osteonecrosis (often termed avascular necrosis with involvement of the epiphyseal regions) is a relatively common disease in which there is ischemic death of the cellular elements of bone or marrow. The femoral heads are the most commonly affected sites, with estimates of symptomatic femoral head osteonecrosis of 2 to 4.5 per patient year, resulting in 10,000 to 20,000 new cases annually in the United States. Because the majority of patients are asymptomatic, this incidence likely significantly underestimates the true prevalence of osteonecrosis. Osteonecrosis affects both children and adults and there are numerous predisposing causes, including dislocation of the hip, femoral neck fracture, corticosteroid usage, alcoholism, collagen vascular disease, hemoglobinopathies, Gaucher disease, caisson disease, and some skeletal dysplasias.

In adults with collapse of the femoral head, disabling hip pain may result in the need for a hemiarthroplasty, hip resurfacing arthroplasty, or total joint replacement in early adulthood. Nontraumatic osteonecrosis is bilateral in 70% to 80% of cases, which further increases the extent of disability in the setting of femoral head collapse. The high incidence of bilateral involvement of osteonecrosis in systemic disease with the use of corticosteroids in children often requires imaging of the contralateral hip. Unlike adults, in the skeletally immature patient there is the potential for remodeling of the deformed femoral head. Thus, in the pediatric population the prognosis depends on the age of onset of the disease and the extent of femoral head deformity.

There are no specific physical findings or laboratory examinations that can reliably establish the diagnosis of osteonecrosis. Clinically suspected osteonecrosis can be confirmed only by diagnostic imaging or biopsy. Imaging methods that can assist in establishing the diagnosis include radiography, computed tomography (CT), radionuclide bone scintigraphy, and magnetic resonance imaging (MRI), with or without contrast enhancement. These methods vary considerably in their cost, diagnostic accuracy, and the information provided.

Although the optimal treatment for femoral head osteonecrosis is debated, early diagnosis is important. First, establishing that osteonecrosis is the cause for a patient's hip pain allows exclusion of conditions such as infection, neoplasm, fracture, arthritis, femoroacetabular impingement syndrome, labral tear, adjacent tendon injury, or other soft-tissue abnormality. Second, accurate diagnosis and staging of osteonecrosis are needed to assess the efficacy of treatment.

Overview of Imaging Modalities

*Radiography*

Radiographs are the least expensive and most widely available imaging technology. Radiographs should be obtained as the initial study in every patient suspected to have osteonecrosis. In the presence of osteonecrosis, the radiograph findings may be normal, abnormal, or equivocal. Both anteroposterior of the pelvis and frog-leg lateral views of the hip should be obtained because articular collapse or cortical depression may be seen on only 1 of the 2 projections. In children, the earliest radiographic findings of osteonecrosis include a smaller ossific nucleus, increased radiodensity, subchondral fracture, and metaphyseal radiolucencies. Subsequently, fragmentation, resorption, reossification, and remodeling of the affected femoral head and neck are seen.

*Computed Tomography*

In adults, CT with multiplanar reconstruction has been reported to be less sensitive than bone scintigraphy and MRI. However, there have been

few studies comparing MRI to current-generation multidetector CT (MDCT) scanners. One study using MDCT showed it was superior to MRI and radiography for detecting articular collapse of the femoral head in adult osteonecrosis. Major roles for CT are in determining the severity of articular collapse and its location and evidence of early secondary degenerative joint disease. This information is useful in surgical planning for rotational osteotomy, arthroplasty, resurfacing procedures, or joint replacement. In the pediatric population, CT is not commonly used for assessment of osteonecrosis.

*Bone Scintigraphy*

More recently, MRI has largely replaced radionuclide bone scintigraphy because of its greater sensitivity (up to 100%, compared to 90% for radionuclide bone scanning). The addition of single-photon emission CT (SPECT) may improve the accuracy of radionuclide imaging for diagnosing osteonecrosis. In one study, SPECT was found to be more accurate than noncontrast MRI for detecting early osteonecrosis after renal transplant. If bone scintigraphy is to be undertaken, it is suggested that the study be done using pinhole collimation and SPECT with scatter correction and iterative reconstruction algorithms. More recently, SPECT/CT has been advocated compared to SPECT alone for the diagnosis of osteonecrosis. In the pediatric population, it is now less common to use nuclear imaging owing to concerns of radiation exposure.

*Magnetic Resonance Imaging*

MRI is the most sensitive and specific radiologic modality in the detection of osteonecrosis. Recent studies report an improved specificity for MRI in detecting osteonecrosis. In the adult population, 2 potential causes for incorrect diagnosis of osteonecrosis by MRI are transient osteoporosis and subchondral insufficiency fracture. Attention to the specific MRI findings usually allows differentiation of these 2 entities. Transient osteoporosis of the hip demonstrates osteopenia of the femoral head on radiography, diffuse intense increased radionuclide uptake in the femoral head (without central photopenia, as with osteonecrosis) on all bone scintigraphy phases, and marrow replacement of the femoral head on T1-weighted MRI that reveals marked diffuse increased signal intensity on water-sensitive sequences (without areas of low signal intensity in the superolateral femoral head, as with osteonecrosis). In subchondral insufficiency fracture the low-signal-intensity band in the superolateral femoral head is convex to the articular surface, as opposed to concave in osteonecrosis, and contrast enhancement is seen commonly (90%) proximal to this area. Although MRI costs more than radionuclide bone scintigraphy, a limited MRI examination may permit the diagnosis of osteonecrosis at a lower cost.

Osteonecrosis of the hip in childhood is typically idiopathic and referred to as Legg-Calvé-Perthes disease. In the pediatric population, several studies have suggested a role for contrast-enhanced MRI. In one study using contrast-enhanced MRI with subtraction technique, the region of hypoperfusion was more clearly delineated in the early stages of Legg-Calvé-Perthes disease. This technique has also been shown to predict the femoral head deformity in a small cohort at 2-year follow-up. Other studies using dynamic technique have detected disease at an earlier stage prior to other MRI manifestations, particularly with Legg-Calvé-Perthes disease, with increased peak enhancement and delayed time to peak enhancement. This technique has also been used to identify femoral heads at risk for development of osteonecrosis subsequent to femoral neck fracture.

MRI can also be useful in both adults and children to detect asymptomatic osteonecrosis in the contralateral hip.

MRI with diffusion sequences, T2 mapping, and apparent diffusion coefficient mapping has also been advocated more recently, although the usefulness of these techniques for evaluation of osteonecrosis remains investigative.

Disease Progression

In the adult population, the long-term clinical importance of osteonecrosis is largely predicated on its likelihood of subchondral and subsequent articular collapse. Imaging identification of factors that increase this possibility is therefore important to guide potential therapy. Osteonecrosis that involves >30% of the femoral head progresses to collapse in 46% to 83% of hips, in contrast to osteonecrosis that involves <30% of the femoral head, which progresses in <5% of cases. Additionally, lesions involving <30% of the femoral head are unlikely to become symptomatic or require treatment. The sagittal plane has been emphasized as optimal in evaluating articular collapse on MRI. Various staging systems include the Association Research Circulation Osseous, Ficat and Arlet, and Steinberg, although their interobserver and intraobserver reliability has been questioned. All of these staging systems have in common progression from radiologically occult disease to positive imaging manifestations of osteonecrosis, followed by femoral head collapse and subsequent development of secondary osteoarthritis. The volume of joint effusion, presence of prominent edema about the focus of osteonecrosis, patient age (>40 years), and body mass index ($\geq$24 kg/m$^2$) have been associated with increased stage and likelihood of femoral head collapse. As described above, in the pediatric population disease progression and outcome are determined by the age of onset of the disease, the extent of femoral head involvement, and subsequent development of femoral head deformity.

Treatment

Treatment of osteonecrosis in the adult population with significant potential for articular collapse or symptomatic lesions includes core decompression, injection of autologous bone marrow mononuclear cells with core decompression, fibular grafting, bisphosphonates,

extracorporeal shock wave therapy, and hyperbaric oxygen. Additional literature suggests that core decompression should be performed only when the area of involvement as measured by MRI is small, although the natural history of these lesions suggests that progression even without treatment is unlikely. In the pediatric population the treatment is based on the age of disease onset, associated symptoms, and extent of femoral head involvement. Treatment options range from nonoperative symptomatic treatment to weight relief and casting to surgical procedures such as femoral or pelvic osteotomies. Early intervention has been shown to improve outcome. Although most osteonecrosis is discovered during imaging for pain, asymptomatic osteonecrosis is commonly found in individuals who are imaged for a symptomatic contralateral hip or unrelated reasons. In children, bilateral involvement of idiopathic osteonecrosis occurs in 15% to 20% and is most often asynchronous in disease onset.

Discussion of Imaging Modalities by Variant

*Variant 1: Adult or Child. Clinically Suspected Osteonecrosis. First Study*

The initial imaging study in either an adult or child with clinically suspected osteonecrosis should be radiography. These images must include a frog-leg lateral view. The important features of osteonecrosis can be seen only on this projection. Although radiography is not sensitive for early changes of osteonecrosis, it is the least expensive and most widely available imaging modality. Identification of characteristic features and detection of articular collapse at radiography may obviate the need for additional imaging. Additionally, radiographs may demonstrate an alternative diagnosis such as hip arthritis, fracture, or tumor involvement as a cause of symptoms in cases where osteonecrosis is not present.

*Variant 2: Adult. Clinically Suspected Osteonecrosis. Normal Radiographs or Radiographs That Show Femoral Head Lucencies Suspicious for Osteonecrosis*

In the adult patient with suspected osteonecrosis of the hip and normal or suspicious radiographs but clinically requiring further radiologic assessment, MRI is the modality of choice. MRI is generally considered the most sensitive and specific radiologic method of assessment for identification of osteonecrosis, with accuracy of 97% to 100% in several series. In one animal study, MRI findings of osteonecrosis were apparent as early as 1 week following induced vascular imaging.

Intravenous contrast is typically not used or necessary for the diagnosis or evaluation of femoral head osteonecrosis. However, several researchers have described the identification of the lack of contrast enhancement on dynamic contrast-enhanced MRI as the most sensitive to detect osteonecrosis in animal studies. This technique may be useful to suggest foci of osteonecrosis subsequent to femoral neck fracture, which has been reported in up to 75% of cases.

*Variant 3: Child. Clinically Suspected Osteonecrosis. Normal Radiographs or Radiographs Suspicious for Osteonecrosis*

In a child with suspected femoral head osteonecrosis with normal radiographs or radiographic evidence of osteonecrosis but in whom further evaluation is needed, MRI is the radiologic modality of choice. Similar to the adult patient, MRI is both sensitive and specific for the identification of osteonecrosis in the pediatric population. However, in contradistinction to the adult patient, the use of contrast-enhanced MRI is often advocated. In early stages of femoral head osteonecrosis, absence of enhancement or hypoperfusion on postcontrast MRI including dynamic subtraction techniques has been described as superior to noncontrast MRI assessment.

Dynamic subtraction MRI techniques demonstrate increased peak enhancement in early stages of Legg-Calvé-Perthes disease. In addition, prognostic features can be assessed by MRI, as discussed previously (see Variants 3 and 4). Bone scintigraphy and CT are not commonly used in radiologic assessment of osteonecrosis of the femoral head in the pediatric population owing to the increased radiation exposure.

*Variants 4 and 5: Adult or Child. Osteonecrosis with Femoral Head Collapse by Radiographs in the Painful Hip(s). Surgery Contemplated*

In the adult or child patient with pain and radiographic evidence of articular collapse resulting from femoral head osteonecrosis and with surgical intervention contemplated for treatment, further imaging assessment is typically required. MRI features that are associated with articular collapse include involvement of >25% to 50% of femoral head volume, older patient age (>40 years), increasing joint effusion volume, prominent surrounding marrow edema, and large body mass index ($\geq$24 kg/m$^2$). MRI may also be useful to determine the degree and location of articular collapse, which is optimally evaluated in the sagittal imaging plane, and the status of the contralateral hip. However, MDCT was superior to radiography and MRI to detect articular collapse location and extent in several studies and can be used if not adequately assessed by MRI for further assessment of preoperative planning. This assessment of the extent and location of articular collapse is often important to guide treatment options, including rotational osteotomy or core decompression.

The use of contrast-enhanced MRI including dynamic subtraction techniques has been advocated for evaluation of osteonecrosis in the pediatric population and may have prognostic implications. Contrast-enhanced MRI features associated with a worsened outcome include lack of revascularization of the lateral pillar, transphyseal neovascularization pattern, physeal disruption, and enhancing synovial hypertrophy.

Additional imaging features associated with a poorer outcome in the pediatric population include larger volume of femoral head involvement, lateral subluxation of the femoral head, loss of femoral head containment, and increased fragmentation. Diffusion-weighted MRI has also been studied in the pediatric population, with increased diffusivity reflecting cell damage compared to a normal femoral head. Increased diffusivity in the metaphyseal region has been associated with a worsened outcome in the pediatric population.

*Variant 6: Adult or Child. Osteonecrosis Clinically Suspected. Radiographs Normal or Abnormal but MRI Contraindicated. Further Evaluation Is Needed*

The imaging assessment of a patient, adult or child, who cannot undergo MRI but requires further radiologic evaluation can be performed with either bone scintigraphy or CT. Bone scintigraphy should be performed with high-resolution pinhole collimation and is particularly useful in patients with normal radiographs. More recently, SPECT has been shown to improve the diagnostic accuracy of this technique. In one study, SPECT was found to be more sensitive than MRI in identifying early femoral head osteonecrosis in renal transplantation patients (100% versus 66%). The disadvantage of bone scintigraphy in assessment of osteonecrosis is the lack of anatomic evaluation and specificity.

CT, although less sensitive than MRI and bone scintigraphy for detection of early femoral head osteonecrosis, is more specific and has the advantage of allowing anatomic assessment (particularly in patients with abnormal radiographs). Osteonecrosis of the femoral head that is more chronic is well seen on CT evaluation. In addition, similar to MRI, sagittal and coronal MDCT allows assessment of the volume of femoral head involvement, the presence of articular collapse, and early secondary degenerative disease. The use of intravenous contrast is not needed for CT evaluation of femoral head osteonecrosis. The CT assessment of femoral head osteonecrosis in this clinical scenario is important to guide the need and types of further treatment that may be required.

Summary of Recommendations

- When a patient who is at high risk for osteonecrosis develops hip pain, the initial examination should consist of an anteroposterior pelvis and frog-leg lateral radiograph of the symptomatic hip or both hips.
- If the radiographic findings are definite for osteonecrosis, an MRI might be indicated if identification of asymptomatic osteonecrosis in the contralateral hip is clinically important.
- If the radiographic findings are equivocal for osteonecrosis or are normal on the symptomatic side, then MRI is indicated to establish the diagnosis of osteonecrosis and to exclude other potential causes for the patient's hip pain.
- In adult patients with radiographically proven, occult, or equivocal osteonecrosis, MRI may be indicated for diagnosis, evaluation of extent or volume of disease, and evidence of articular collapse, if clinically important to guide optimal treatment. CT (MDCT) can be useful for preoperative assessment if not adequately evaluated by MRI.
- In adult patients in whom MRI cannot be performed, bone scintigraphy with SPECT, or preferably SPECT/CT, imaging is a reasonable alternative for diagnosing radiographically occult osteonecrosis. In these patients, CT can also be useful to identify the extent or volume of disease and evidence of articular collapse, if clinically important.
- In children, if the diagnosis is equivocal or occult at radiography, perfusion MRI can be helpful to establish the diagnosis and to assess the extent of abnormal perfusion.
- In children, CT and bone scintigraphy are infrequently used given the concern of radiation exposure. Less commonly, bone scintigraphy can be used if MRI is contraindicated and early definitive diagnosis is required.
- Screening of a patient who is at high risk for osteonecrosis may be of value if prophylactic treatment of asymptomatic osteonecrosis is proven useful.

Abbreviations

- CT, computed tomography
- MRI, magnetic resonance imaging
- Tc, technetium
- SPECT, single-photon emission computed tomography

Relative Radiation Level Designations

| Relative Radiation Level* | Adult Effective Dose Estimate Range | Pediatric Effective Dose Estimate Range |
|---|---|---|
| O | 0 mSv | 0 mSv |
| | <0.1 mSv | <0.03 mSv |
| | 0.1-1 mSv | 0.03-0.3 mSv |

| Relative Radiation Level* | Adult Effective Dose Estimate Range | Pediatric Effective Dose Estimate Range |
|---|---|---|
| | 1-10 mSv | 0.3-3 mSv |
| | | |
| | 10-30 mSv | 3-10 mSv |
| | 30-100 mSv | 10-30 mSv |

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

### Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

## Scope

### Disease/Condition(s)

Osteonecrosis of the hip (often termed avascular necrosis with involvement of the epiphyseal regions)

### Guideline Category

Diagnosis

Evaluation

### Clinical Specialty

Family Practice

Geriatrics

Internal Medicine

Nuclear Medicine

Orthopedic Surgery

Pediatrics

Physical Medicine and Rehabilitation

Radiology

### Intended Users

Advanced Practice Nurses

Health Plans

Hospitals

Managed Care Organizations

Physician Assistants

Physicians

Students

Utilization Management

## Guideline Objective(s)

To evaluate the appropriateness of imaging modalities for diagnosis and staging of osteonecrosis of the hip

## Target Population

Adult and pediatric patients with suspected or confirmed osteonecrosis of the hip

## Interventions and Practices Considered

1. X-ray, pelvis and hips (includes the frog-leg view)
2. Computed tomography (CT), hips
    - Without contrast
    - With contrast
    - Without and with contrast
3. Technetium (Tc)-99m bone scan with single-photon emission computed tomography (SPECT), hips
4. Magnetic resonance imaging (MRI), hips
    - Without contrast
    - Without and with contrast

## Major Outcomes Considered

- Sensitivity, specificity, and accuracy of imaging procedures in diagnosis of osteonecrosis of the hip
- Utility of imaging procedures in the diagnosis and treatment of osteonecrosis of the hip

# Methodology

## Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

## Description of Methods Used to Collect/Select the Evidence

Literature Search Summary

Of the 22 citations in the original bibliography, 19 were retained in the final document. Articles were removed from the original bibliography if they were more than 10 years old and did not contribute to the evidence or they were no longer cited in the revised narrative text.

A new literature search was conducted in December 2013 to identify additional evidence published since the *ACR Appropriateness Criteria® Osteonecrosis of the Hip* topic was finalized. Using the search strategy described in the literature search companion (see the "Availability of

Companion Documents" field), 77 articles were found. Twenty-eight articles were added to the bibliography. Forty-nine articles were not used due to either poor study design, the articles were not relevant or generalizable to the topic, the results were unclear, misinterpreted, or biased, or the articles were already cited in the original bibliography.

The author added 20 citations from bibliographies, Web sites, or books that were not found in the new literature search.

## Number of Source Documents

Of the 22 citations in the original bibliography, 19 were retained in the final document. The new literature search conducted in December 2013 identified 28 articles that were added to the bibliography. The author added 20 citations from bibliographies, Web sites, or books that were not found in the new literature search.

## Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

## Rating Scheme for the Strength of the Evidence

Definitions of Study Quality Categories

Category 1 - The study is well-designed and accounts for common biases.

Category 2 - The study is moderately well-designed and accounts for most common biases.

Category 3 - The study has important study design limitations.

Category 4 - The study or source is not useful as primary evidence. The article may not be a clinical study, the study design is invalid, or conclusions are based on expert consensus.

The study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);

*Or*

The study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;

*Or*

The study is an expert opinion or consensus document.

Category M - Meta-analysis studies are not rated for study quality using the study element method because the method is designed to evaluate individual studies only. An "M" for the study quality will indicate that the study quality has not been evaluated for the meta-analysis study.

## Methods Used to Analyze the Evidence

Systematic Review with Evidence Tables

## Description of the Methods Used to Analyze the Evidence

The topic author assesses the literature then drafts or revises the narrative summarizing the evidence found in the literature. American College of Radiology (ACR) staff drafts an evidence table based on the analysis of the selected literature. These tables rate the study quality for each article included in the narrative.

The expert panel reviews the narrative, evidence table and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the variant table(s). Each individual panel member assigns a rating based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development documents (see the "Availability of Companion Documents" field).

## Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

## Description of Methods Used to Formulate the Recommendations

Rating Appropriateness

The American College of Radiology (ACR) Appropriateness Criteria (AC) methodology is based on the RAND/UCLA Appropriateness Method. The appropriateness ratings for each of the procedures or treatments included in the AC topics are determined using a modified Delphi method. An initial survey is conducted to elicit each panelist's expert interpretation of the evidence, based on the available data, regarding the appropriateness of an imaging or therapeutic procedure for a specific clinical scenario. The expert panel members review the evidence presented and assess the risks or harms of doing the procedure balanced with the benefits of performing the procedure. The direct or indirect costs of a procedure are not considered as a risk or harm when determining appropriateness (additional assumptions regarding rating appropriateness can be found in the document Rating Round Information ). When the evidence for a specific topic and variant is uncertain or incomplete, expert opinion may supplement the available evidence or may be the sole source for assessing the appropriateness.

The appropriateness is represented on an ordinal scale that uses integers from 1 to 9 grouped into three categories: 1, 2, or 3 are in the category "usually not appropriate" where the harms of doing the procedure outweigh the benefits; and 7, 8, or 9 are in the category "usually appropriate" where the benefits of doing a procedure outweigh the harms or risks. The middle category, designated "may be appropriate," is represented by 4, 5, or 6 on the scale. The middle category is when the risks and benefits are equivocal or unclear, the dispersion of the individual ratings from the group median rating is too large (i.e., disagreement), the evidence is contradictory or unclear, or there are special circumstances or subpopulations which could influence the risks or benefits that are embedded in the variant.

The ratings assigned by each panel member are presented in a table displaying the frequency distribution of the ratings without identifying which members provided any particular rating. To determine the panel's recommendation, the rating category that contains the median group rating without disagreement is selected. This may be determined after either the first or second rating round. If there is disagreement after the first rating round, a conference call is scheduled to discuss the evidence and, if needed, clarify the variant or procedure description. If there is still disagreement after the second rating round, the recommendation is "may be appropriate."

This modified Delphi method enables each panelist to articulate his or her individual interpretations of the evidence or expert opinion without excessive influence from fellow panelists in a simple, standardized, and economical process. For additional information on the ratings process see the Rating Round Information document.

Additional methodology documents, including a more detailed explanation of the complete topic development process and all ACR AC topics can be found on the ACR Web site (see also the "Availability of Companion Documents" field).

## Rating Scheme for the Strength of the Recommendations

Not applicable

## Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

## Method of Guideline Validation

Internal Peer Review

## Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria (AC).

# Evidence Supporting the Recommendations

## Type of Evidence Supporting the Recommendations

The recommendations are based on analysis of the current medical evidence literature and the application of the RAND/UCLA appropriateness method and expert panel consensus.

Summary of Evidence

Of the 67 references cited in the *ACR Appropriateness Criteria® Osteonecrosis of the Hip* document, 59 are categorized as diagnostic references including 2 well designed studies, 12 good quality studies, and 17 quality studies that may have design limitations. Additionally, 8 references are categorized as therapeutic references including 7 well designed studies. There are 29 references that may not be useful as primary evidence.

While there are references that report on studies with design limitations, 21 well designed or good quality studies provide good evidence.

# Benefits/Harms of Implementing the Guideline Recommendations

## Potential Benefits

Early diagnosis of osteonecrosis is important. First, establishing that osteonecrosis is the cause for a patient's hip pain allows exclusion of conditions such as infection, neoplasm, fracture, arthritis, femoroacetabular impingement syndrome, labral tear, adjacent tendon injury, or other soft-tissue abnormality. Second, accurate diagnosis and staging of osteonecrosis are needed to assess the efficacy of treatment.

## Potential Harms

Relative Radiation Level

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the American College of Radiology (ACR) Appropriateness Criteria® Radiation Dose Assessment Introduction document (see "Availability of Companion Documents" field).

# Qualifying Statements

## Qualifying Statements

- The American College of Radiology (ACR) Committee on Appropriateness Criteria (AC) and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments.

Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

- ACR seeks and encourages collaboration with other organizations on the development of the ACR AC through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document.

# Implementation of the Guideline

## Description of Implementation Strategy

An implementation strategy was not provided.

# Institute of Medicine (IOM) National Healthcare Quality Report Categories

## IOM Care Need

Getting Better

Living with Illness

## IOM Domain

Effectiveness

# Identifying Information and Availability

## Bibliographic Source(s)

Murphey MD, Roberts CC, Bencardino JT, Appel M, Arnold E, Chang EY, Dempsey ME, Fox MG, Fries IB, Greenspan BS, Hochman MG, Jacobson JA, Mintz DN, Newman JS, Rosenberg ZS, Rubin DA, Small KM, Weissman BN, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness CriteriaÂ® osteonecrosis of the hip. Reston (VA): American College of Radiology (ACR); 2015. 12 p. [67 references]

## Adaptation

Not applicable: The guideline was not adapted from another source.

## Date Released

2015

## Guideline Developer(s)

American College of Radiology - Medical Specialty Society

## Source(s) of Funding

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

## Guideline Committee

Committee on Appropriateness Criteria, Expert Panel on Musculoskeletal Imaging

## Composition of Group That Authored the Guideline

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## Financial Disclosures/Conflicts of Interest

Not stated

## Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Seeger LL, Daffner RH, Weissman BN, Arnold E, Bancroft L, Bennett DL, Blebea JS, Fries IB, Jacobson JA, Morrison WB, Payne WK III, Resnik CS, Roberts CC, Schweitzer ME, Taljanovic M, Wise JN, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness Criteria® avascular necrosis (osteonecrosis) of the hip. [online publication]. Reston (VA): American College of Radiology (ACR); 2009. 5 p. [22 references]

This guideline meets NGC's 2013 (revised) inclusion criteria.

## Guideline Availability

Available from the American College of Radiology (ACR) Web site .

## Availability of Companion Documents

The following are available:

- ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2015 Oct. 3 p. Available from the American College of Radiology (ACR) Web site .
- ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 2015 Feb. 1 p. Available from the ACR Web site .
- ACR Appropriateness Criteria®. Evidence table development. Reston (VA): American College of Radiology; 2015 Nov. 5 p. Available from the ACR Web site .
- ACR Appropriateness Criteria®. Topic development process. Reston (VA): American College of Radiology; 2015 Nov. 2 p. Available from the ACR Web site .
- ACR Appropriateness Criteria®. Rating round information. Reston (VA): American College of Radiology; 2015 Apr. 5 p. Available from

the ACR Web site .

- ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 2015 Sep. 3 p. Available from the ACR Web site .
- ACR Appropriateness Criteria®. Manual on contrast media. Reston (VA): American College of Radiology; 2015. 129 p. Available from the ACR Web site .
- ACR Appropriateness Criteria®. Procedure information. Reston (VA): American College of Radiology; 2015 Jul. 2 p. Available from the ACR Web site .
- ACR Appropriateness Criteria® osteonecrosis of the hip. Evidence table. Reston (VA): American College of Radiology; 2015. 28 p. Available from the ACR Web site .
- ACR Appropriateness Criteria® osteonecrosis of the hip. Literature search. Reston (VA): American College of Radiology; 2015. 1 p. Available from the ACR Web site .

## Patient Resources

None available

## NGC Status

This NGC summary was completed by ECRI on May 6, 2001. The information was verified by the guideline developer as of June 29, 2001. The summary was updated by ECRI on January 27, 2006. This summary was updated by ECRI Institute on May 18, 2010. This summary was updated by ECRI Institute on January 22, 2016.

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